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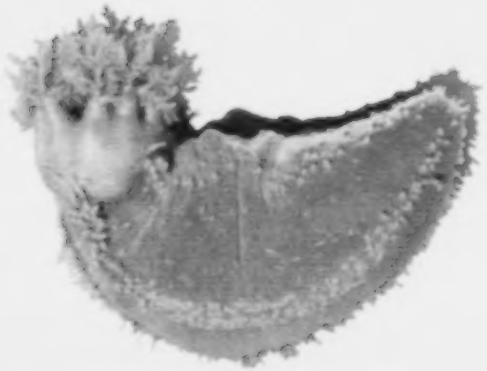
Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/050

ASSESSMENT OF THE SEA CUCUMBER FISHERY IN QUEBEC'S INSHORE WATERS IN 2016



Picture : Jean-Paul Dallaire, DFO

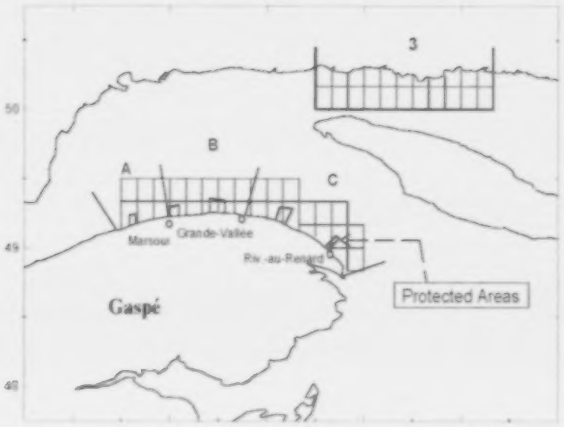


Figure 1. Sea cucumber management units (Units A, B, C, and 3) in Quebec and protected areas.

Context :

The sea cucumber (Cucumaria frondosa) fishery is a recent activity in the Estuary and northern Gulf of St. Lawrence. It began in 2008 on the Gaspé Peninsula's north shore and in 2009, on the Middle North Shore near Havre-Saint-Pierre. This fishery is carried out either by diving or by using an LGS-type dredge or a dredge specifically designed for sea cucumbers on the North Shore. Harvested cucumbers are processed in Quebec and in Maine, and products are exported mainly to Asian markets. There is currently no local market.

In 2004, a study was conducted to determine the potential of this fishery on the Gaspé Peninsula. Following this study, initial exploratory licenses were issued for Units A, B, C and 3, as well as an experimental license for Unit 4 (now merged to Unit 3) and for the Magdalen Islands.

The resource is assessed every three years to determine whether changes that have occurred in stock status require adjustments to the conservation approach and management plan. This assessment follows the one produced in 2014 (DFO 2014) for the sea cucumber in the Estuary and the northern Gulf of St. Lawrence.

SUMMARY

- The sea cucumber fishery began in Quebec in 2008 and is still in the exploratory stage. Total landings were 1037 t in 2016, with 49% coming from the Gaspé Peninsula's north shore (Units B and C) and 51% from the North Shore (Unit 3).

Gaspé Peninsula

Unit B

- Landings have increased from 2009 to 2014, peaking at 608 t. The TAC of 600 t was lowered to 350 t in 2015. There was no fishery in 2015 and landings then fell to 160 t in 2016, partly in response to the reduction of the harvestable area. Effort fell from an average of 38 days from 2011 to 2013 to 23 days in 2016.
- Catches per unit effort (CPUE) also increased from 2009 to 2014, reaching 787 kg/hm in 2014. A significant decline in CPUE in 2016 is partly explained by the change in management measures.
- In Unit B, the size of cucumbers caught at sea was greater in 2014 and 2016 than it was from 2011 to 2013.

Unit C

- The TAC of 800 t fell to 382 t in 2015. Landings fell in 2015 and 2016 to 271 t and 351 t, respectively, after the reduction in the harvestable area. Effort has been relatively stable since 2011, ranging from 37 to 52 fishing days, except in 2014 when it reached 84 fishing days.
- The mean CPUE was 432 kg/hm from 2011 to 2013, but it dropped sharply in 2014 then stabilized at a historic minimum of about 200 kg/hm in 2015 and 2016.
- In Unit C, the mean commercial size of cucumbers caught at sea was relatively stable from 2011 to 2014, but it increased in 2015 before falling again—to its lowest level—in 2016.

North Shore

Unit 3

- Authorized effort went from 70 to 100 fishing days in 2014. Landings were between 192 and 335 t during the 2011–2013 period; they then increased to a maximum of 526 t in 2016.
- The CPUE went from an average of 226 kg/hm from 2011 to 2013 to an average of 254 kg/hm for the 2014–2016 period. The increase is related to new harvesting in the western portion of the Unit in 2016.
- The mean commercial size of the individuals measured at sea decreased in 2016 and is now at its lowest level since 2009.

Recommendations

- Unit B: The recommendation is to keep the TAC near its current level for the next three years.

- Unit C: The TAC in effect since 2015 has caused pressure on the fishery that does not seem to allow the available biomass to be maintained. Lowering the TAC by a percentage equivalent to that of the decrease in the CPUE and the harvestable area combined is recommended. The new TAC should be in the range of 352 t.
- Unit 3: The recommendation is to keep the fishing effort near the current level for the next three years.
- During the interim years, adjusting the fishing effort (Unit 3) or the TAC (Units B and C) only when there is a significant decline in CPUE is recommended. A decrease in CPUE of 20% or more in relation to the average or reference value of the Unit (Unit 3: 2009–2015; Unit B: 2016 and Unit C: 2015–2016) should result in an equivalent decrease in the TAC in Units B and C or in the fishing effort in Unit 3. In case of an increase in CPUE, no adjustment to the fishing effort or to the TAC would be made before the next assessment.
- In addition, recommendations include creating one or more refuge areas in Unit 3 and maintaining monitoring of accidental catches in all three units.

BACKGROUND

Species Biology

The sea cucumber, *Cucumaria frondosa*, is an echinoderm founds in the north Atlantic and Arctic oceans. It is found in most habitats in the Estuary and the Gulf of St. Lawrence. In the south, its range extends to Cape Cod. The sea cucumber lives in depths of less than 10 m during its early years and later migrates very slowly to depths of up to 60 m. However, it can be found at depths of over 400 m. It has five rows of tube feet that allow it to move and to attach to substrates. It prefers complex rocky bottoms or mixed substrates of gravels, stones, sand and shells. The sea cucumber feeds on phytoplankton and zooplankton by spreading out its ten tentacles, which capture plankton suspended in the water column or organic matter sitting nearby on the substrate. The tentacles are covered with sticky mucus, which aids in harvesting. Each tentacle is retracted individually into the sea cucumber's mouth, where the plankton is then eaten. The species has very low mobility. Sea cucumbers gather in aggregations known as "beds"; this behaviour ensures a certain level of success in reproduction, which is achieved by external fertilization.

According to the data available for Quebec, sea cucumber spawning occurs in mid-June, later than that observed in the Bay of Fundy (April–May), Newfoundland (February–May) and Maine (March–April). The sea cucumber has separate sexes but does not exhibit sexual dimorphism. New larvae undergo an initial 48-hour pelagic phase, after which they settle, preferring the undersides and sides of gravel as well as rocks with crevices.

In Quebec, the size at which the cucumbers begin to reach sexual maturity would be between 80 and 102 mm, which is higher than in Newfoundland (Grant et al. 2006). According to another study done in Newfoundland (So et al. 2011), this species would require at least 25 years to reach a size of 150 mm, while in the Gulf of St. Lawrence, the maximum size is reached at an estimated minimum age of 10 years (Hamel and Mercier 1996). In Quebec, the maximum size observed in the commercial fishery is 285 mm.

Protecting at least one natural bed in each management unit is often recommended as a conservation measure for this species in order to ensure a certain reproductive success.

Fishery

Two different methods are used to harvest sea cucumbers. The first method, dive fishing, consists of diving underwater and removing the animals, either with or without the use of a siphon connected to a pump at the surface. This method is mandatory in Unit A and was used only in 2009. The second method, drag fishing, consists of towing a dredge behind a fishing boat. The dredges used in Quebec are lighter and more compact than the LGS (Light Green Sweep Urchin) drag type, which was developed in the United States for harvesting green sea urchins. In Quebec, sea cucumber dredges vary in width: a maximum of 2.45 m in Unit 3 and 3.65 m in Units B and C.

The sea cucumber fishery began in Quebec in 2008 and is still in the exploratory stage. The first trial of sea cucumber fishing in Quebec was conducted in 2008 in Unit C, in the northern part of the Gaspé Peninsula (Figure 1). Catches for this trial totalled 201 t. The following year, the fishery was extended to Unit A (diving), to Unit B, adjacent to Unit C, and to Unit 3 in the Mingan region on the North Shore. A minimum size of 114 mm has now been in effect in all zones since 2013. For all units in Quebec, catches totalled 1037 t in 2016. In 2010, protected areas were established along the Gaspé coast corresponding to about 15% of the licensed fishing territory (Figure 2). In 2015, Units B and C were subdivided into five and six sub-units, respectively, to better distribute the fishing effort throughout the unit (Figure 2). Fishing depths varied somewhat by unit: under 20 m in Unit A, 32 to 42 m in Units B and C and over 20 m in Unit 3. Only one licence was issued in each until 2012. Additional licences were issued in Unit 3 and in Units B and C in 2012 and in 2013, respectively. In all of the units, this fishery is in the exploratory stage, except for the additional licence in Unit 3 which is still in the experimental stage.

In Units A, B and C, fisheries are managed by TAC. These TACs were determined from information obtained in the preliminary inventory, which was taken in 2004 (Campagna et al. 2005). In Unit 3, the fishery is managed by effort control (i.e. by limiting the number of fishing days each season). To the 70-day limit authorized since 2010 another 30 days is now added for the experimental licence.

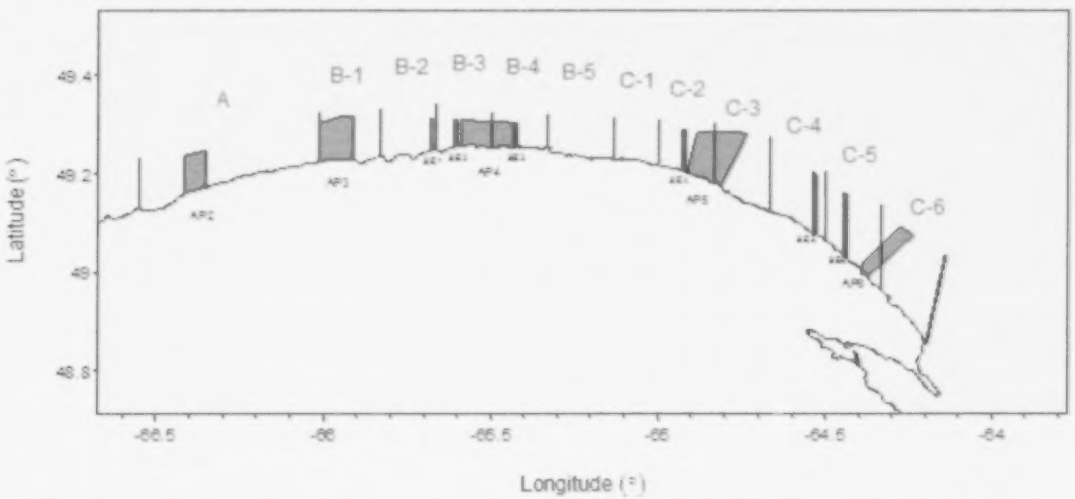


Figure 2. Units A, B and C of the sea cucumber fishery in the Gaspé Peninsula and their subdivisions. There are protected areas (PA-2 to PA-6) and sites closed to fishing (SE1 to SE6).

ASSESSMENT

The data on fishing effort and CPUE used in this assessment come from the harvesters' logbooks. The size structures and mean sizes of sea cucumbers were taken from the DFO landed commercial catch sampling program and from at-sea sampling by the At-Sea Observer Program. The fishing positions were obtained from logbooks.

Drag Fishery

In 2016, total landings were 1037 t, with 49% coming from the Gaspé Peninsula's north shore (Units B and C) and 51% from the North Shore (Unit 3) (Figure 3).

On the Gaspé Peninsula, in Unit B, commercial fishery landings increased from 2009 to 2014, when they peaked at 608 t, exceeding the 2009 TAC of 600 t (Table 1). Two licences have been active over the past two years. As a result of the reduction in harvestable area to prevent gear conflicts with the rock crab fishery, the allowed depth went from 22–40 m in 2011–2014 to 32–42 m in 2015. The TAC was then reduced to 350 t and subdivided according to the five sub-units created in 2015 (Table 2). There was no fishery in 2015, and 2016 saw a catch of only 160 t from a single licence. Effort went from an average of 38 fishing days from 2011 to 2013 to 23 days in 2016. The mean CPUE also increased between 2009 and 2014, when it peaked at 787 kg/hm (kilograms per hour/meter), and it decreased by more than half to 336 kg/hm in 2016. This decrease is partly due to changes in management measures, including a substantial reduction in harvestable area. Since the available fishing area is smaller and their quota distributed among the five sub-units, harvesters have to exploit their entire area. As a result, there remain few still-unexploited sites to improve CPUE.

In Unit C, the 2009 TAC of 800 t was almost reached from 2012 to 2014 (Table 1). With the subdivision of Unit C into six sub-units in 2015 as a result of the reduction in harvestable area, the TAC was reduced to 382 t. Even though two licences have been active since 2013, only 271 t were landed in 2015 and 351 t in 2016. Effort has been relatively stable since 2011, ranging from 37 to 52 fishing days, except in 2014 when it reached 84 fishing days. The mean CPUE was 432 kg/hm from 2011 to 2013 but declined sharply in 2014, when effort peaked. It then stabilized at a historical low of about 200 kg/hm in 2015 and 2016.

On the North Shore, in Unit 3, the fishing effort limit of 70 days set in 2010 was changed to 100 days with the addition of a new licence in 2014 (Table 1). Landings remained below 400 t until 2013 and then increased to a maximum of 526 t in 2016. The CPUE went from an average of 226 kg/hm from 2011 to 2013 to an average of 254 kg/hm for the 2014–2016 period. In 2016, the CPUE reached its highest value of the series. This increase is related to the newly exploited western portion of the unit in 2016, and to the abandonment of the eastern portion, which is less productive (Figure 3).

The size structures of sea cucumbers sampled at sea show maximum sizes of 200 to 240 mm depending on the Unit (Figure 4). The mean commercial size of individuals measured at sea was greater in 2014 and 2016 than it was from 2011 to 2013 in Unit B (DFO 2014). In Unit C, it was relatively stable from 2011 to 2014, but it increased in 2015 before falling again—to its lowest level—in 2016. In Unit 3, the mean commercial size decreased in 2016 and is now at its lowest level since 2009, and most of the sea cucumbers measured were of sub-legal size.

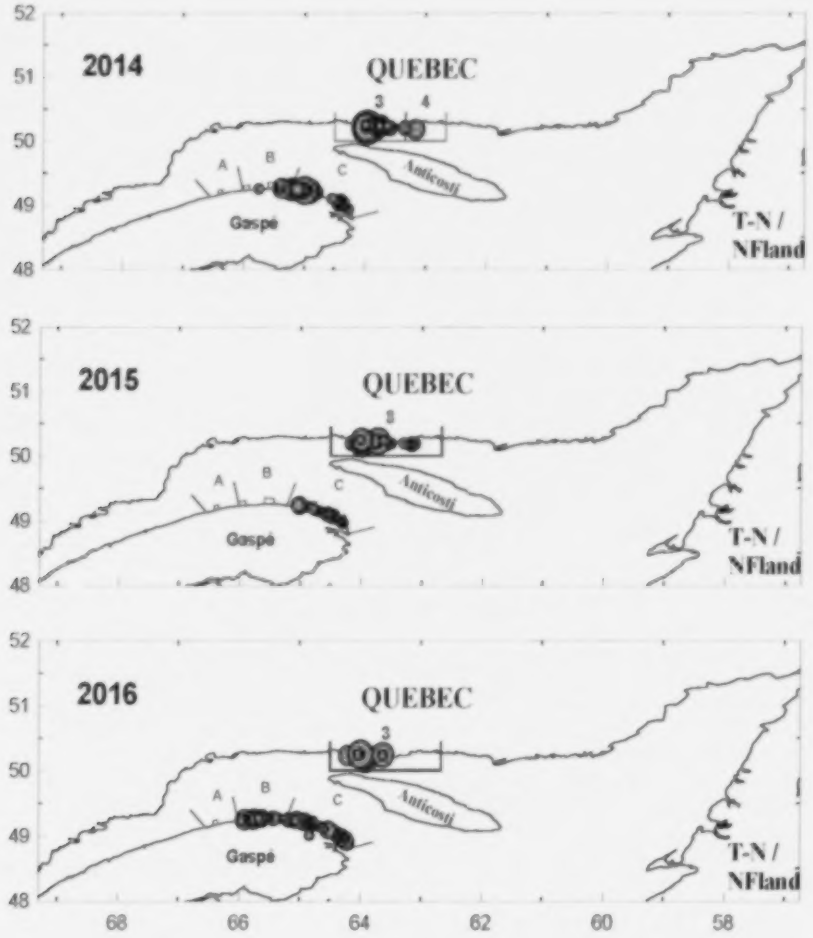


Figure 3. Sea cucumber fisheries in Quebec from 2014 to 2016. The size of the circles represents the relative fishing effort (number of trips made) in that position.

Table 1. Total allowable catch (TAC in t) or quota in fishing days (days), catches (t) and catch per unit effort (CPUE in kg/hm) in the Quebec commercial sea cucumber drag fishery from 2008 to 2016.

Year	Unit B				Unit C				Unit 3			
	TAC (t)	Catches (t)	Effort (days)	CPUE (kg/hm)	TAC (t)	Catches (t)	Effort (days)	CPUE (kg/hm)	Quota (days)	Catches (t)	Effort (days)	CPUE (kg/hm)
2008	-	-	-	-	200	201	13	392	-	-	-	-
2009	600	135	20	296	800	324	19	433	35	113	23	234
2010	600	23	5	172	800	292	22	379	70	361	68	249
2011	600	291	35	276	800	507	37	381	70	294	64	241
2012	600	410	41	351	800	785	49	408	70	335	67	233
2013	600	534	37	648	800	740	50	507	70	192	43	205
2014	600	608	35	787	800	791	84	296	70	416	80	235
2015	350	0	-	0	382	271	37	199	70+30	452	83	250
2016	350	160	23	336	382	351	52	203	70+30	526	91	277
Average	**-**	**270**	**28**	**358**	**-**	**474**	**40**	**355**	**-**	**336**	**65**	**240**

Table 2. Total allowable catch (TAC in t) by sub-unit for the commercial sea cucumber fishery in Units B and C in Quebec since 2015.

Unit B		Unit C	
Sub-unit	TAC (t) 32-32 m	Sub-unit	TAC (t) 32-42 m
B-1	72	C-1	76
B-2	44	C-2	41
B-3	62	C-3	66
B-4	86	C-4	41
B-5	86	C-5	86
Total	350	C-6	72
		Total	382

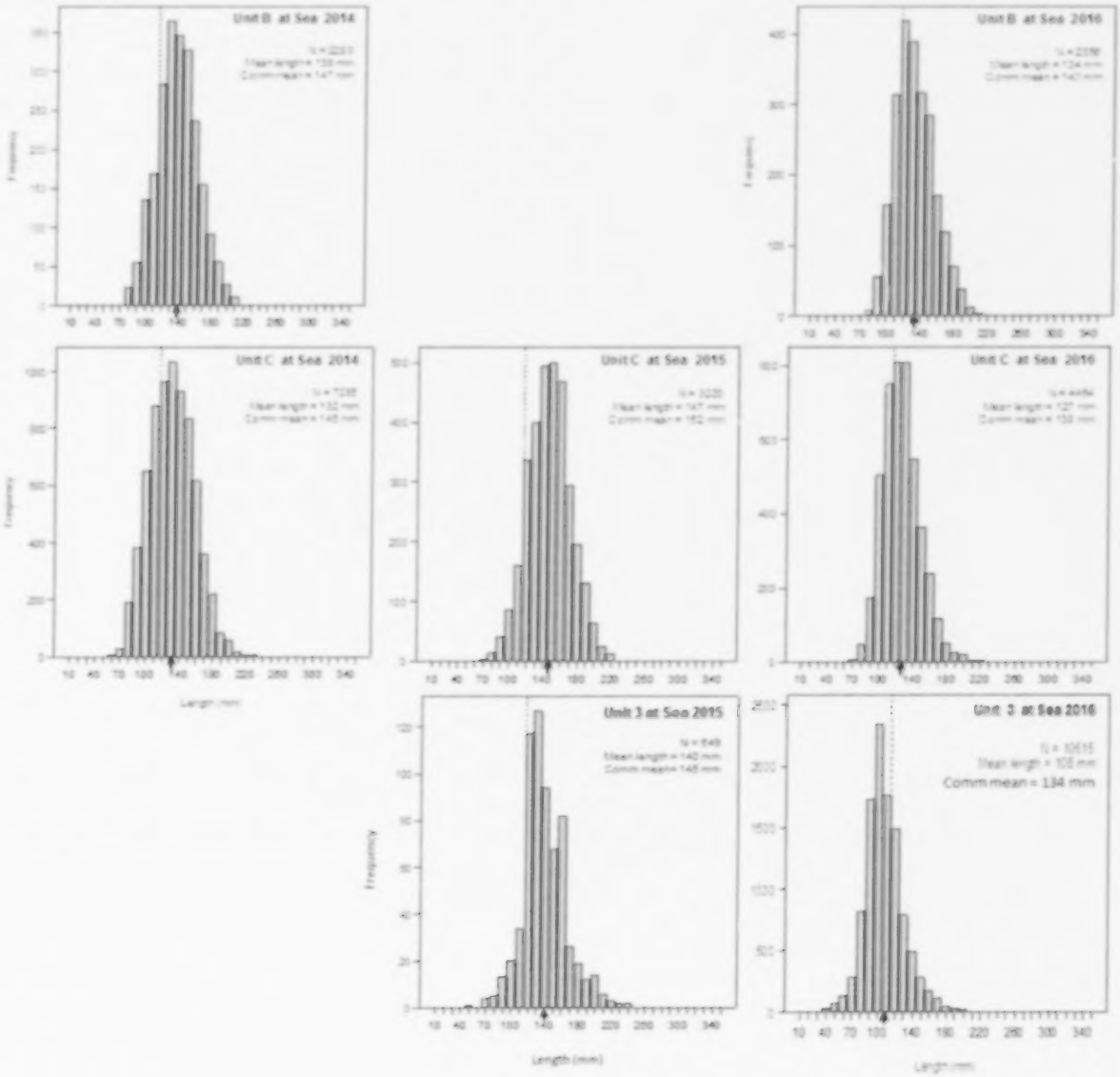

Unit B at Sea 2014
Unit B at Sea 2016
Unit C at Sea 2014
Unit C at Sea 2015
Unit C at Sea 2016
Unit 3 at Sea 2015
Unit 3 at Sea 2016
Comm mean = 134 mm
Frequency
Length (mm)

Figure 4. Size structure and number (n) of sea cucumbers measured at sea from the drag fishery in Units B, C and 3 from 2014 to 2016. The vertical dotted line represents the minimum catch size of 114 mm. The mean size of all individuals (Mean size) and the mean size of 114 mm or more (Comm mean) are indicated. The arrow shows the mean size of all individuals harvested.

Bycatch

From 2011 to 2016, the sum of the 9 main bycatch species in Units B, C and 3 represented from 3 to 18% of the total number of individuals caught by dragging (Table 3). This bycatch seems to be on the rise in recent years. In Unit 3, sampled only in 2011 and 2015, the percentage of the total bycatch count was similar to that of the two other units, but the composition of species was

different. There was a predominance of green sea urchins and toad crabs (*Hyas araneus*) in Unit 3, while in Units B and C, the quantity of starfish was much higher. The rock crab seems to be proliferating everywhere.

Table 3. Quantities of sea cucumbers in number and percentage of the total number of individuals caught including all species, and percentage of the total number of individuals caught of the main bycatch species in each unit during the 2011 to 2016 sea cucumber fishery in Quebec. The percentage (% bycatch) in the last column represents the proportion of the nine main bycatch species harvested in relation to the total number of species caught.

Year	Unit	Sea cucumber		Main bycatch species (% of total)									% bycatch
		N	%	Urchin	Hyas	Rock crab	Snow crab	Soft coral	Scallop	Whelk	Anemone	Starfish	
2011	3	34864	93.8	4.8	0.4	0.1	0.0	0.0	0.0	0.1	0.0	0.8	6
	C	310634	95.6	0.0	1.1	0.9	0.0	0.0	0.1	0.0	0.0	2.3	4
2012	B	254288	91.4	1.4	1.8	1.0	0.0	0.0	0.4	0.1	0.3	3.5	9
	C	574490	92.7	0.1	1.2	1.5	0.0	0.0	0.1	0.0	0.2	4.2	7
2013	B	413966	93.6	0.2	1.0	1.3	0.0	0.0	0.2	0.0	0.4	3.4	6
	C	434479	89.9	0.3	1.0	2.3	0.0	0.1	0.7	0.2	0.3	6.3	10
2014	B	283247	96.7	0.3	0.0	0.8	0.0	0.0	0.2	0.0	0.0	2.2	3
	C	541232	89.9	0.1	0.8	2.1	0.0	0.3	0.5	0.2	0.4	7.0	10
2015	3	16891	81.7	7.6	9.8	1.9	0.0	0.0	0.0	0.1	0.0	3.0	18
	C	177324	94.0	0.0	0.1	1.7	0.0	0.0	0.0	0.1	0.3	4.1	6
2016	B	120400	82.7	0.7	0.1	5.4	0.0	0.0	0.8	0.2	0.9	12.9	17
	C	183849	83.7	2.7	0.2	3.9	0.0	0.0	0.9	0.1	0.5	11.1	16

Sources of Uncertainty

The sea cucumber fishery is currently done using fishing gears still in development and differing greatly from one sector to another. CPUE estimates between these sectors and annually could be influenced by these differences. In addition, fishing techniques favored by harvesters, such as dredging speed, cable length, towing direction relative to the current, towing duration and the period during which the dredge is towed, may also have an influence. The number of fishers is not constant each year, especially in Gaspé. Interannual variations are possible if they do not visit the same sites from one year to another or if their technique differs from one to the other.

The mean sizes of sea cucumber measured at sea or landed are directly influenced by the technique used by the sampler to ensure that all individuals are sufficiently contracted and by the time elapsed between the time of the fishing and the measurement.

The conclusions of this advice also depend largely on the quality of the information obtained with logbooks completed by fishermen and purchase slips collected at the dock. Any omissions or errors will influence the parameters estimation of sea cucumber stocks.

CONCLUSIONS AND ADVICE

Drag fishing

Drag fishing is still in the exploratory stages in Quebec and only one part of the shores of the St. Lawrence is currently being fished. Since the fishery is relatively new, we lack sufficient knowledge at this time to be able to determine an optimal exploitation rate. The TACs

established for Units A, B and C could therefore be reassessed as new information becomes available. For this type of fishery, management by controlling fishing effort could be considered for each unit. For this and all other emerging fisheries, any increase in fishing effort must be achieved slowly and incrementally, and even then only if catches are at the maximum granted quota and if the stock status has been stable or improving for a number of years. Furthermore, the differences already observed between the sites suggest that management regimes should be developed specifically for each locale.

The gear currently being used should be improved so as to minimize bycatch and impacts on habitats. The impacts in the short, medium and long term are currently being assessed.

Recommendations

For Unit B, it is recommended that the TAC be maintained close to the current level of 350 t for the next three years. In Unit C, the TAC in effect since 2015 has caused pressure on the fishery that does not seem to allow the available biomass to be maintained. Lowering the TAC by a percentage equivalent to that of the decrease in the CPUE and the harvestable area combined is recommended. The new TAC should be in the range of 352 t.

For Unit 3, it is recommended that the fishing effort be maintained close to the current level for the next three years.

During the interim years, adjusting the fishing effort (Unit 3) or the TAC (Units B and C) only when there is a significant decline in CPUE is recommended. A decrease in CPUE of 20% or more in relation to the average or reference value of the unit (Unit 3: 2009–2015, Unit B: 2016, and Unit C: 2015–2016) should result in an equivalent decrease in the TAC in Units B and C or in the fishing effort in Unit 3. In the case of an increase in CPUE, no adjustment to the fishing effort or to the TAC would be made before the next assessment.

In addition, recommendations include creating one or more refuge areas in Unit 3 and maintaining monitoring of bycatch in all three units.

OTHER CONSIDERATIONS

Commercial exploitation of most species of sea cucumber around the world is done by dive harvesting. Despite the rudimentary means at the disposal of these harvesters, a number of stocks have collapsed and show no signs of recovery, which suggests we should be cautious about exploiting *Cucumaria frondosa* in our waters. We have no information on the resilience of this species at this latitude compared to species in more temperate regions.

We must work to improve our knowledge on biological and ecological aspects, which is still lacking in many areas, notably by mapping sea cucumber beds; determining the spawning season in our waters, growth rates, and the size at sexual maturity; and establishing the impact of the fishing gear on other marine species.

The industry also actively participates in improving our knowledge. Work done by the Mi'kmaq Maliseet Aboriginal Fisheries Management Association (MMAFMA) in Units B and C aims to compare the yield at fished and unfished sites, obtain basic information on sea cucumbers (mean size, maximum size, depths, etc.) and potentially to work on improving the dredges used.

SOURCES OF INFORMATION

This Science Advisory Report is from the June 6, 2017 Assessment of the Sea Cucumber fishery in the Quebec's inshore waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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